Impacts of Irrigation on Land Surface Model Physics and Numerical Weather Prediction

Joseph A. Santanello, Jr.[1] and Patricia Lawston- GSFC Summer Intern[2], 1 – GSFC, Code 617, 2 - University of Delaware

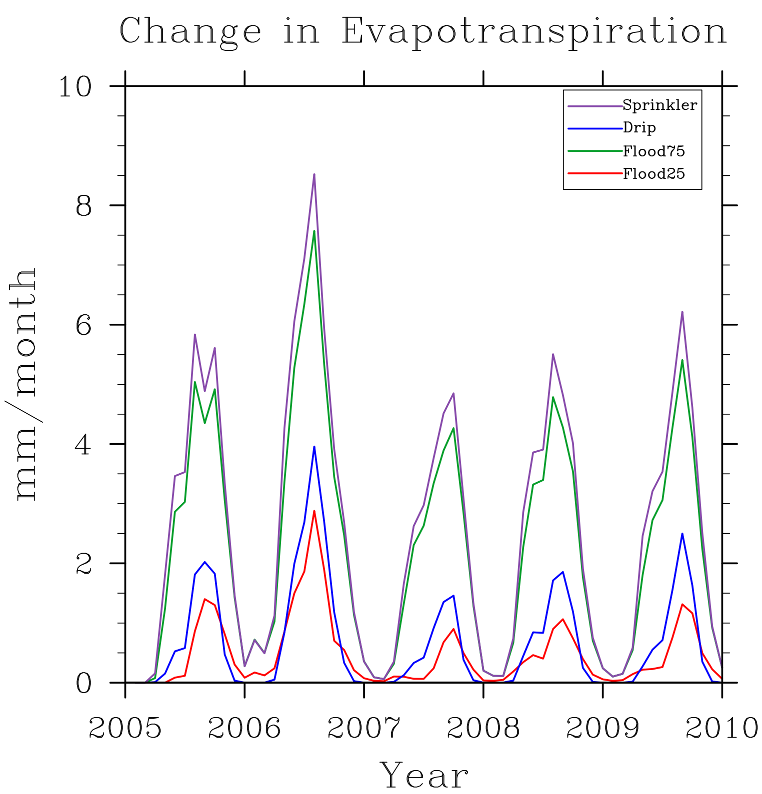

Figure. 1: Domain averaged monthly change in evapotranspiration during the 5-year LIS spinup for the 4 irrigation runs versus the control run

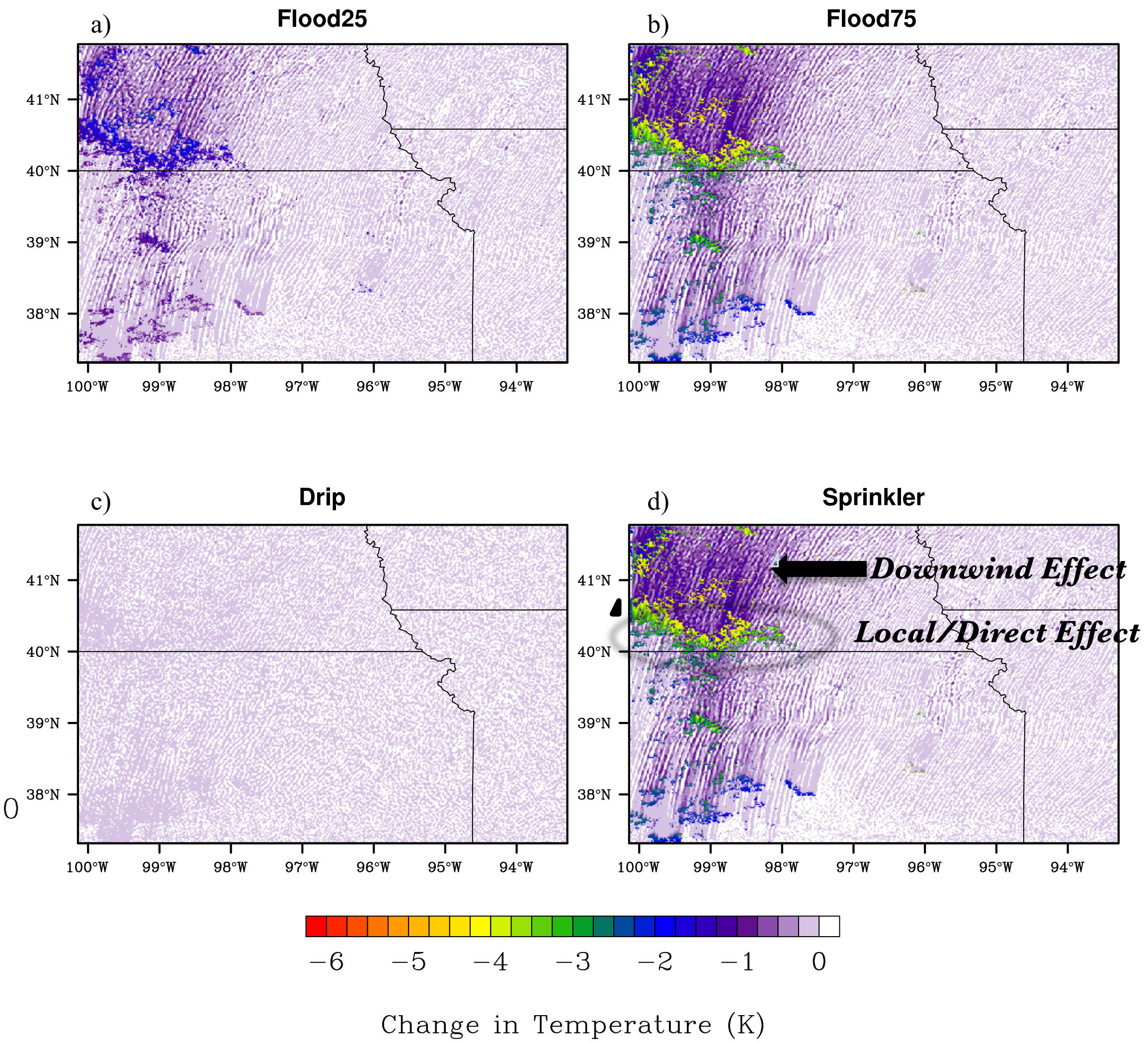

Figure. 2: Difference from control in NU-WRF simulated 2-meter temperature using a) Flood25, b) Flood75, c) Drip, and d) Sprinkler irrigation methods for July 31, 2006 at 19 UTC.

Name: Joseph A. Santanello, Jr., NASA GSFC, Code 617
E-mail: Joseph.A.Santanello@nasa.gov
Phone: 301-286-7450

Abstract: In this study, we examine the impact of different irrigation methods on **land-atmosphere interactions and short-term weather forecasts over the U. S. Central Great Plains** using the **NASA Unified-WRF (NU-WRF)** regional model coupled to **NASA's Land Information System (LIS)**. Two forecast periods were chosen, one in a drier than normal year (2006) and one in a wetter than normal year (2008) to evaluate the sensitivity of the irrigation approaches and impacts to the background climate conditions. Irrigation methods include a Drip and Sprinkler scheme, as well as a flood scheme evaluated at a higher and lower threshold (Flood25 and Flood75, respectively).

Reference: Lawston, P., J. Santanello, B. Zaitchik, and H. Beaudoing, 2013: Impact of Irrigation Methods on LSM Spinup and Initialization of WRF Forecasts. In prep.

Data Sources: The community-supported Weather Research and Forecasting (WRF) model has been coupled to NASA-GSFC's Land Information System (LIS) within the NASA Unified WRF (NU-WRF) system (C. Peters-Lidard; PI), which provides a flexible and high-resolution representation and initialization of land surface physics and states. Land cover classification is provided by the United States Geological Survey (USGS), which is used to identify cropland locations that have potential for irrigation. Output from a five year (2005-2010) LIS spinup of the Noah land surface model, driven by North American Land Data Assimilation System (NLDAS-2) forcing data, was used to initialize WRF experiments. Forecasts were then run for 2 days in a drier than normal year (30-31 July, 2006) and a wetter than normal year (25-26 May, 2008).

Technical Description of Figures:

Figure 1: Domain averaged **monthly change in evapotranspiration** during the 5-year LIS spinup for the 4 irrigation runs versus the control run (no irrigation). Daily differences (irrigation method minus control) are averaged over the domain and over each month of the spinup.

Figure 2: Change in NU-WRF simulated **2-meter air temperature** as a result of using a) Flood25, b) Flood75, c) Drip, and d) Sprinkler irrigation schemes for 31 July, 2006 at 19 UTC. Differences are irrigation method value minus control value. This modeling domain is centered over Kansas and Nebraska.

Scientific significance:

- Initializing an atmospheric model using an irrigated land surface spinup results in significant local changes to surface water and energy fluxes, boundary layer development, and ambient temperature and humidity, as well as downstream effects on clouds and precipitation.
- Local temperature (decreases) and humidity (increases) induced by irrigation can be advected with the mean wind field and lead to the development of convective rolls or "cloud streets" over neighboring areas.

Relevance for future science and relationship to Decadal Survey: In the United States, irrigation represents the largest consumption of fresh water and accounts for approximately one-third of all water usage. As the demand for food and fuel increases with a growing world population, the need to efficiently produce high crop yields may lead to the further expansion of irrigated fields. This study has shown the importance of both irrigation method physics and correct representation of several key components of land surface models including accurate and timely land cover and crop type classification, phenology (greenness), and soil moisture anomalies in coupled prediction models. The bulk of this information can be retrieved from satellite observations of existing (e.g. MODIS, Landsat, GRACE) and planned satellite missions (SMAP). Overall, the inclusion of irrigation physics then has the potential to improve forecasts, which will offer farmers a better tool to adapt to increasing crop demands.

Landsat 8 Surface reflectance product preliminary validation

Eric Vermote, Code 619, NASA GSFC

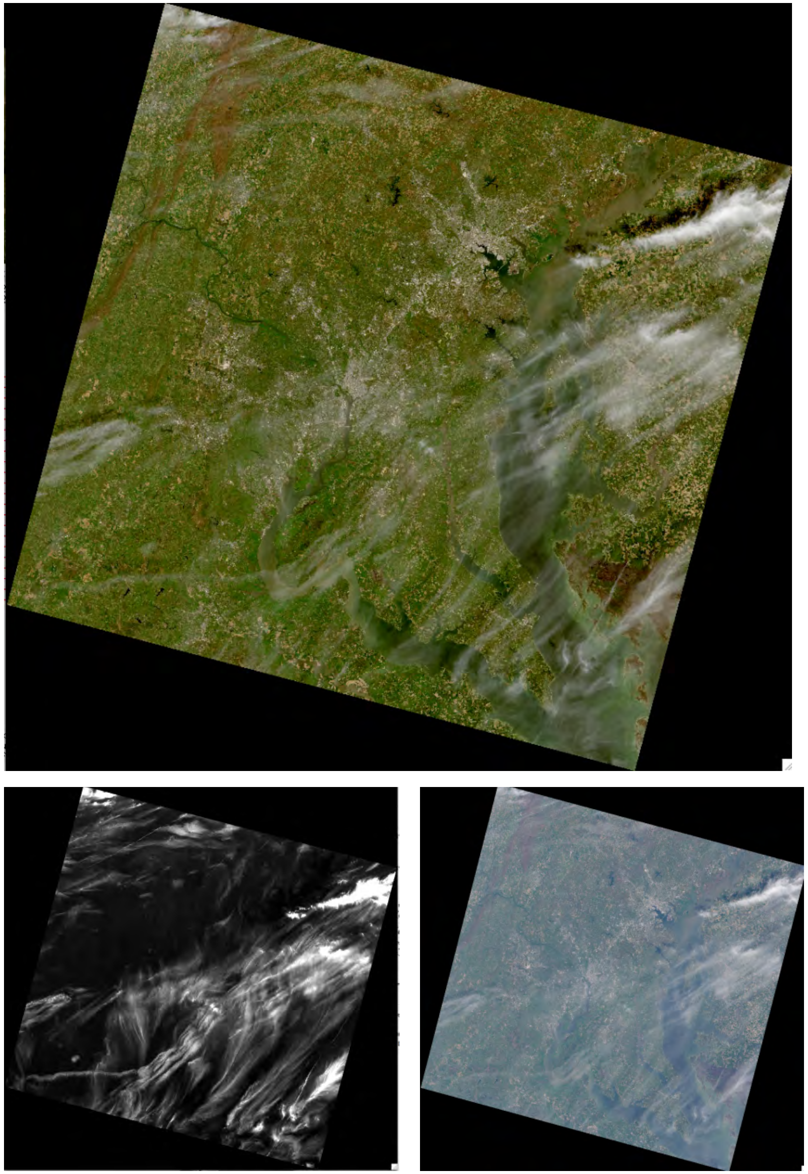

Figure 1: Prototype surface reflectance product from LDCM (top). Image acquired on April 21 2013. This true-color composite was generated using LDCM bands 2,3,4. The surface reflectance product shows coverage of cirrus clouds over the scene which is very well captured by LDCM band 9 (bottom left), the bottom right shows the top of the atmosphere reflectance.

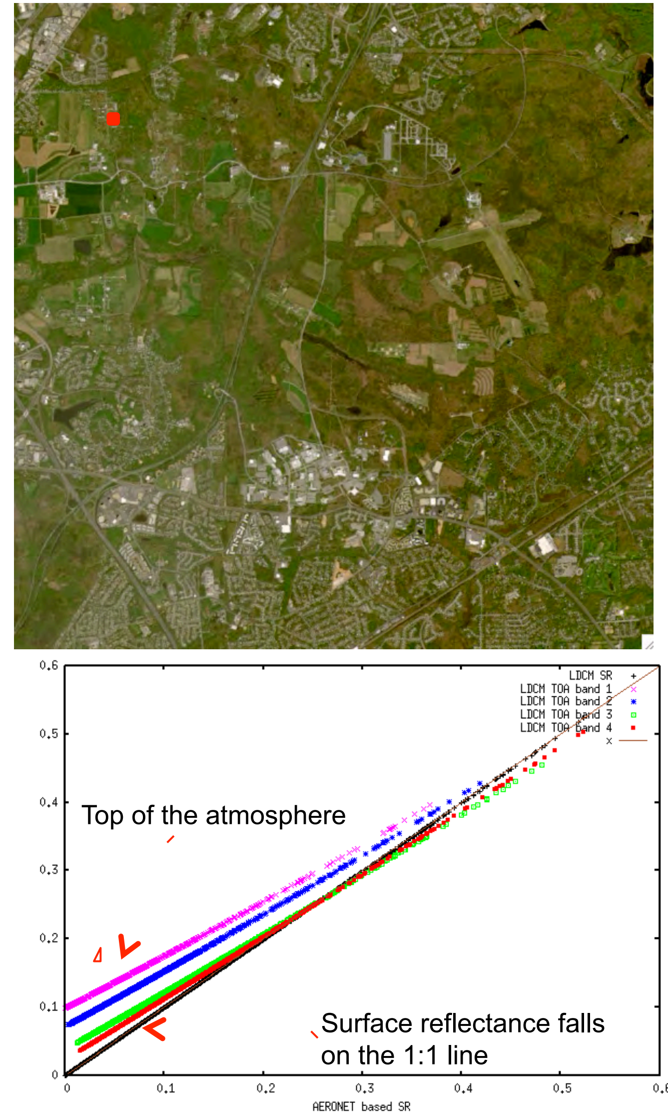

Figure 2: Validation of the LDCM surface reflectance over GSFC AERONET site. Top is the area used for comparison and bottom is the results.

Name: Eric Vermote, NASA/GSFC, Code 619
E-mail: eric.f.vermote@nasa.gov
Phone: 301-614-5413

Abstract:
Using the atmospheric correction scheme developed for MODIS (Vermote and Kotchenova, 2008), Surface Reflectance has been generated from data from several others sensors such as VIIRS and Landsat TM/ETM+ (Masek et al., 2006). The approach adopted relies on inverting the aerosol effect, using the bands centered at the shortest wavelength (in the blue region of the Electromagnetic Spectrum). Due to the difficulty of measuring accurately the reflectance on the ground at the needed scale, the approach for Surface Reflectance accuracy assessment (validation) relies primarily on the use of accurate radiative transfer code and accurate atmospheric and aerosol characterization such as provided by AERONET ground-based measurements. Using the top of the atmosphere reflectance measured by the sensor, the radiative code and AERONET measurements, a reference can be derived that can be compared to the surface reflectance product and accuracy metrics can be derived over a variety of conditions and locations (Ju et al., 2012). We present here the first results obtained with the prototype surface reflectance product from LDCM/Landsat 8.

References:

Ju, J., Roy, D.P., Vermote, E., Masek, J., Kovalskyy, V., 2012, Continental-scale validation of MODIS-based and LEDAPS Landsat ETM+ atmospheric correction methods, **Remote Sensing of Environment**, 122, 175–184. http://dx.doi.org/10.1016/j.rse.2011.12.025

Vermote, E. F., and S. Kotchenova, 2008. Atmospheric correction for the monitoring of land surfaces, **Journal of Geophysical Research**, 113, D23S90, doi:10.1029/2007JD009662.

Masek J.G., Vermote E.F., Saleous N.E., Wolfe R., Hall F.G., Huemmrich K.F., Gao F., Kutler J., Lim T.K., 2006. A Landsat surface reflectance dataset for North America 1990-2000, **IEEE Geoscience and Remote Sensing Letters**, 3, (1), 68-72.

Data Sources: the input data were produced by the USGS, the surface reflectance product is being tested and generated by Code 619.

Technical Description of Figures:

Figure 1: Figure 1: Prototype surface reflectance product from LDCM (top). Image acquired on April 21 2013. This true-color composite was generated using LDCM bands 2,3,4. The surface reflectance product shows coverage of cirrus clouds over the scene which is very well captured by LDCM band 9 (bottom left), the bottom right shows the top of the atmosphere reflectance.

Figure 2: Validation of the LDCM surface reflectance over GSFC AERONET site. Top is the area used for comparison and bottom is the results. The prototype algorithm performs extremely well, the graphs both shows the top of the atmosphere reflectance in band 1 though 4 (colored symbol) and the prototype LDCM surface reflectance in band 1 to 4 (black symbol) as well as the 1:1 line.

Scientific significance:
The spectral bidirectional surface reflectance is a key input parameter to a potential suite a land products e.g. Vegetation indices, Albedo, LAI/FPAR.

Relevance for future science and relationship to Decadal Survey:
This is extremely relevant to future science that necessitate the use of different data set in combination. The surface reflectance is the first step toward the fusion of different data set.